PATENT SPECIFICATION

DRAWINGS ATTACHED

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884556

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International Classification:—**F05b. F05g.**

COMPLETE SPECIFICATION

Improvements in Reciprocating Liquid Pumps of Positive Displacement Type

We, HOBOURN-EATON MANUFACTURING COMPANY LIMITED, a British Company, of 9—11, High Street, Coventry, Warwickshire, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to reciprocating liquid pumps of positive displacement type and has for its object to provide improved compact forms of such pumps, which are especially but not exclusively suitable for high pressure operation. More particularly it is an object of this invention to provide such pumps which combine the characteristic features of a reciprocating pump and of a rotary sliding abutment pump.

With this object in view the invention provides a reciprocating liquid pump comprising two relatively rotatable members, one of which has a track eccentrically disposed in relation to the other member, a plurality of slidable pistons disposed substantially radially of and maintained in end-face contact with said eccentric track and mounted in cylinders which can swivel in said other member, said pistons being ported to co-act during the suction stroke of each piston with ports provided in said eccentric track and communicating with a liquid intake, and discharge valve means for co-operating with each successively charged cylinder to allow passage of liquid from said cylinders during the discharge stroke of each piston through registering eccentric and piston ports, preferably to a common discharge duct. The ports in the contacted surface of the eccentric track are adapted to supply liquid to pumping chambers formed around said eccentric track, so that the pistons function not only as in a reciprocating piston and cylinder pump but also as in a rotary sliding-abutment pump.

In preferred arrangements a fixed pump casing encompasses a rotatable shaft having an eccentric track and the slidable pistons are mounted in the wall of a cross bore provided in the pump casing, in cylinders which swivel about axes parallel to the shaft axis. In such constructions the ports in the pistons carry, on their discharge strokes, liquid which is at a pressure equal to the normal-high working pressure of the pump and this liquid can be considered as constituting columns of liquid which are discharged during the relative rotation of the fixed pump casing and the rotary shaft carrying the eccentric. These liquid columns provide also a medium effecting high pressure lubrication between the pistons and the eccentric, which are in sliding contact with each other, at a reduced loading according to the ratio of the total piston area and total liquid column area.

Provision is made for hydraulic balancing of moving components, so that they operate under control of conditions of pressure differential permitting of high speed working of the pump.

Although a pump in accordance with this invention is primarily intended for high pressure operation it may be readily adapted to provide also a separate low pressure supply, as hereinafter described.

Two embodiments of the invention will now be described, by way of examle, firstly with reference to the drawings accompanying the provisional specification and, wherein:—

Figure 1 is a longitudinal sectional elevation of one form of pump, constructed exclusively for high pressure operation, Figure 1 being a section on line A—A of Figure 2;

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Figure 2 is a transverse sectional view on line B—B of Figure 1; and

Figure 3 is a detail view, to an enlarged scale of one of the pistons and its cylinder.

In the additional drawings which accompany the complete specification;

Figure 4 is a view similar to Figure 1, of another form of pump, in which provision is made for a separate low pressure supply; and

Figures 5 and 6 are fragmentary cross sections on lines C—C and D—D respectively showing discharge and suction control means for the low pressure supply.

In the construction of pump illustrated in Figures 1 to 3, a fixed or stationary pump casing is employed, said casing comprising a body 1 and a cover 2 with an interposed cylinder block 3, all suitably drilled for the reception of holding bolts 4, which may also serve for securing the pump as a whole in position on a suitable supporting structure. The body 1 and the cover 2 have central, axially aligned bores 1A, 2A enclosing needle bearings 5 for supporting the journals of a shaft 6 driven in any suitable manner.

The cylinder block 3 has a bore 3A which is larger than the body and cover bores and is divided as described later to provide the pumping chambers above referred to. Within said block bore 3A is accommodated an eccentric 7 forming part of or attached to said shaft 6 for rotation therewith. The transverse sectional shape of the shaft eccentric 7 is preferably circular, as shown. The cylinder block 3 is also formed with a plurality of transverse cylinder bores 3B which break into the bore 3A and within each of said cylinder bores is a sleeve 8 which is mounted trunnion-fashion within its cylinder bore so as to be free to swivel therein, part of the periphery of the sleeve 8 protruding through the opening formed where the cylinder bore 3B breaks into cylinder block bore 3A.

Each cylindrical sleeve 8 has a through channel 8A extending from end to end, the open channel being closed at one end by the flat inner face 2B of cover 2 and at the other end by the flat inner face 9A of a pressure ring 9, accommodated in an annular recess 1B provided in the inner face of body 1. Pressure ring 9 serves to close another smaller recess 1C leading from recess 1B and constituting a delivery duct 10 whence liquid under pressure is delivered.

Between opposing parallel walls in the mouth of the through channel 8A of each sleeve 8 is slidably mounted a piston or plunger 11 of flat vane form, having a length substantially equal to the length of the sleeve 8, the outer end face 11A of said piston being of concaved circular arc form, with a radius of curvature equal to that of the circular-shaped track of eccentric 7; the sleeve 8 thus forms with its associated vane-like piston 11 a piston and cylinder arrangement as used in reciprocatory pumps. By reason of the swivel action of sleeve 8 within the cylinder bores 3B the vane-like piston 11 is free to adjust itself to the circular-arc surface presented by the eccentric 7, so as to maintain sliding contact between said eccentric 7 and the piston face 11A. Each vane-like piston 11 is biased toward contact with the eccentric 7 by means of a coiled compression spring 12 interposed between the floor of a tunnel-like transvers chamber 15 forming an extension of the sleeve channel 8A and the bottom of a blind socket 11B provided in the inner face of piston 11. The sliding action of the pistons 11 in relation to said eccentric 7 thus causes them to function also as the vanes of a pump of sliding abutment type. Symmetrical to said spring socket 11B are through holes 11C which provide for flow of liquid between the concaved piston face 11A and the chamber formed within sleeve 8 between the inner face of said piston 11, the floor of the sleeve channel 8A and the faces 2B and 9A of cover 2 and pressure ring 9 respectively.

For a purpose hereinafter more particularly described the peripheral surface of sleeve 8 is relieved by a symmetrical base recess 8B and two asymmetrically disposed side recesses 8C of tapering form in cross section, as shown in Figure 3. A base port 8D and side ports 8E (Figure 3) establish free communication for liquid between the interior of sleeve channel 8A via the chamber 15 and the recesses 8B and 8C respectively.

At suitable positions the pressure ring 9 has passages 9B adapted to communicate with the interiors of the sleeve channels 8A, each passage 9B being closed until opened by liquid pressure by means of a ball 13 biased by a coiled compression spring 13A thus constituting a check valve, the action of which is described later.

The peripheral surface or circular-shaped track of eccentric 7 is relieved by a groove 7A which is long enough to register with the spaced holes 11C in each vane-like piston 11, during the period when said piston 11 has just commenced to move from its maximum radially outward position to substantially until it reaches its maximum radially inward position. Into opposite ends of this eccentric groove 7A open two radial passages 7B in the eccentric 7 leading from the bore 7C thereof, which leads into a bore 6A in shaft 6.

Some portion of the peripheral groove 7A of eccentric 7 is thus opened successively to the chambers 14 formed by the bore 3A of block 3, the eccentric 7, the protruding portion of swivel sleeves 8 and portions of the vane-like pistons 11. The chambers 14 also communicate via passages 2C with a common intake recess 2D which is connected to a feed coupling (not shown) secured by screws

engaging tapped holes 2E; the shaft bore 6A also opens into recess 2D.

Oil or hydraulic fluid, hereinafter referred to as the liquid, is admitted through the central bore 6A in shaft 6 and the additional passages 2C in the intake recess 2D to the chambers 14 encircling the eccentric 7.

As the pistons 11 are urged by their springs 12 on the successive inward strokes to maintain contact with the periphery of eccentric 7 liquid passes through the holes 11C in the pistons via the relieving groove 7A of the eccentric 7 and/or the holes 7B from the bore 7C and shaft bore 6A. On the commencement of the outward stroke, the holes 11C in the pistons are successively cut-off from the relieved portion of the eccentric 7 thus allowing the liquid to be delivered through the appropriate check valve 13 into the common discharge duct 10.

When a piston 11 is at the outer end of its stroke the check valve 13 closes under its spring 13A and the holes 11C in the piston 11 register again with the relieving groove 7A of the eccentric 7, whereupon the cycle recommences.

In order to run the pump at high pressures, it is essential that the finite clearances between the pistons 11 and sleeves 8 should be controlled at a minimum. It is also necessary that the contact surfaces between the sleeves 8 and cylinder block 3 and the pistons 11 and eccentric 7 should be relieved of excess loading, which can be accomplished by utilizing hydraulic pressure in a manner now to be described.

It will be realised that the holes 11C in each piston 11 on the discharge stroke carry liquid at a pressure equal to the working pressure of the pump, and this liquid can be considered as columns of liquid which are discharged through the check valve 13 by means of the rotation of eccentric 7. These columns of liquid also serve to provide a means of high pressure lubrication between the pistons 11 and eccentric 7, which are slidably in contact with each other, at a reduced loading according to the ratio of the total area of pistons and associated liquid columns.

By reason of the small clearance necessarily allowed between a sleeve 8 and its bore 3B in the cylinder block 3, there is always a tendency for the sleeve 8 to move radially inwards by reason of build-up of pressure of liquid passing through the finite clearance between sleeve 8 and cylinder block 3.

This sealing effect may be augmented or enhanced by providing on the sleeve 8, normal to the direction of radial sliding of a piston 11 within said sleeve, flat surfaces against which liquid pressure acts. That is, each sleeve 8 may be so designed that the pressure build-up within the chamber 15 is also applied to three pre-determined areas on the outside of the sleeve through ports 8D and 8E. The areas "B" on each side of a sleeve 8 are equal to areas on the side walls of the pressure chamber 15, so as to equalize inside and outside pressures at right angles to the axis of the piston 11. "D" is the area of the floor recess 6B.

It will be seen that by closely controlling the differential of areas "A" and "D" to the piston area it is possible to control the forces urging the sleeve 8 to move radially inwards, which at high pressures will tend to keep the clearance between sleeve 8 and piston 11 to a minimum, thus ensuring a seal between their contacting surfaces and enabling high pressure working in the pump. This control of differential will also enable clearance at low pressures to be satisfactorily arranged.

It is to be noted that the check valve 13 is housed in a pressure plate 9 which is always urged into contact with the side face of cylinder block 3 by the pressure build-up in the discharge duct 10, thus ensuring finite clearance between the sides of the pistons 11 and the cover 2.

One advantage of this construction is that in the event of wear on the sides of the pistons after long service, the initial finite clearance can be restored by lapping the surfaces of the cylinder block 3 and pressure plate 9, thus restoring the pump to its initial working efficiency.

The modified construction of pump illustrated in Figures 4 to 6 is of the same general form as that shown in Figures 1 to 3 and where identical or similar components are employed they have the same reference characters as used in Figures 1 to 3.

The main difference is the provision of recesses 16, 17 on opposite sides of the shaft eccentric 7 and opening into the cylinder block bore 3A. Within each of the recesses 16 and 17 is accommodated plate 18, the plates being of identical form, and each plate having an eccentric cut-away portion or gap 19 forming a peripheral port. By reversing the same plate 18 it may serve either as a discharge plate or as a suction plate as shown clearly in Figures 5 and 6. The plates 18 are held fast to eccentric 7 by dowel pins 20, which cause said plates to rotate with the shaft 6, but hold them against rotation and in fixed relation to the eccentric 7. At least one of the passages 2C is in communitation at all times with the gap 19 in the plate 18 on the intake side of the pump.

An annulus 21 adjoins and opens into the recess 16 and communicates with a suitable passageway (not shown) serving for the discharge of low pressure liquid. If it is desired to use this pump solely for high pressure operation the suction and discharge plates 18 are simply removed or omitted, the liquid displaced by the pistons 11 as they function as sliding abutments being allowed to circulate in the plate recesses 16 and 17.

WHAT WE CLAIM IS:—

1. A reciprocating liquid pump of positive displacement type comprising two relatively rotatable members, one of which has a track eccentrically disposed with respect to the other member, a plurality of slidable pistons disposed substantially radially of and maintained in end-face contact with said eccentric track and mounted in cylinders which can swivel in said other member, said pistons being ported to co-act during the suction stroke of each piston with ports provided in said eccentric track and communicating with a liquid intake, and discharge valve means for cooperating with each successively charged cylinder to allow passage of liquid from said cylinders during the discharge stroke of each piston through registering eccentric and piston ports.

2. A pump as claimed in Claim 1, wherein the relatively rotatable members are constituted by a fixed pump casing encompassing a rotatable shaft having an eccentric track and the slidable pistons are mounted in a cross bore of the pump casing, in cylinder which swivel about axes parallel to the shaft axis.

3. A pump as claimed in Claim 1 or Claim 2, wherein the ports in the contacted surface of the eccentric track are adapted to supply liquid to pumping chambers encircling said eccentric track, so that the pistons function not only as in a reciprocating piston and cylinder pump but also as in a rotary sliding-abutment pump.

4. A pump as claimed in any one of the preceding claims, wherein during the discharge stroke of each piston hydraulic balancing is provided for urging the piston toward the co-operating eccentric track and the cylinder into sealing contact with a seating on which it is swivel-mounted.

5. A pump as claimed in any one of the preceding claims characterised in that slipper or vane-type pistons are slidable within cylinders of open-end channelled sleeve form rockable about their longitudinal axes.

6. A pump as claimed in Claims 4 and 5, further characterised in that one or more flat surfaces is or are provided on the exterior of each swivel-mounted sleeve, said surface(s) being normal to the direction of sliding of a piston within the sleeve.

7. A pump as claimed in Claim 5 or Claim 6, wherein each swivel sleeve has a pressure chamber therewithin open at least on one side to permit of lateral discharge of liquid toward said discharge valve means mounted alongside of the swivel sleeves and pistons, said sleeve pressure chamber communicating through axial ports in its co-acting piston with ports leading from the contacted surface of the eccentric track to provide for flowing of liquid from the liquid intake which opens into the casing cross bore into which the pistons project.

8. A pump as claimed in Claim 7, wherein a pressure plate under influence of discharging pressure liquid is held in lateral contact with the swivel sleeves, a non-return valve being mounted in said pressure plate in direct alignment with said pressure chamber of each swivel sleeve.

9. A pump as claimed in any of the preceding Claims 2 to 8, in which end-face contact of each piston with the eccentric track is maintained by biasing springs.

10. A pump as claimed in any one of the preceding Claims 2 to 8, wherein end-face contact of each piston with the track of the eccentric is maintained by coupling each piston with said eccentric to positively control the piston throughout its reciprocation relative to its cylinder.

11. A pump as claimed in Claim 10, characterised in that the ends of the eccentric track and lateral extensions of all the adjacent pistons are embraced by retaining rings which hold the piston captive in relation to the eccentric.

12. A pump as claimed in any one of the preceding Claims 3 to 11, in which ported plates are mounted at opposite sides of the eccentric to control flow of liquid from the pumping chambers to provide a separate supply of low-pressure liquid.

13. A reciprocating liquid pump of positive displacement type, constructed substantially as herein described with reference to the drawings accompanying the provisional specification.

14. A pump as claimed in Claim 13 modified by the inclusion of porting plates to give a low-pressure supply, substantially as described with reference to Figures 4, 5 and 6 of the accompanying drawings.

STEVENS, LANGNER, PARRY & ROLLINSON,
Chartered Patent Agents,
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PROVISIONAL SPECIFICATION

Improvements in Reciprocating Liquid Pumps of Positive Displacement Type

We, HOBOURN-EATON MANUFACTURING COMPANY LIMITED, a British Company, of 9—11, High Street, Coventry, Warwickshire, do hereby declare this invention to be described in the following statement:—

This invention relates to rotary pumps of positive displacement type and has for its object to provide a novel and compact form of fluid pump, suitable for high pressure operation. More particularly it is an object of

this invention to provide a pump which combines the characteristic features of a reciprocating pump and a rotary sliding abutment pump.

With this object in view the invention provides a fluid pump comprising a pump casing and a shaft mounted for relative rotation, said shaft carrying a circular-shaped eccentric turning within a chamber in said casing, a plurality of slidable pistons disposed substantially radially of and maintaining end-face contact with said eccentric and mounted in cylindrical supports adapted to swivel about axes parallel to the shaft axis, said pistons being ported to co-act with ports provided in the contacted surface of said eccentric and communicating with a fluid intake, and valve means co-operating with successive cylinders to control discharge of fluid flowing through registering eccentric and piston ports into said cylinders. The above mentioned eccentric ports also supply fluid under pressure to the chamber enclosing the eccentric, so that the pistons function not only as in a reciprocating piston and cylinder pump but also as in a rotary sliding-abutment pump.

In a preferred arrangement, the ports in the pistons carry, on their discharge strokes, fluid which is at a pressure equal to the working pressure of the pump and this fluid can be considered as constituting columns of fluid which are discharged during the relative rotation of the pump casing and the shaft carrying the eccentric. These fluid columns provide also a medium effecting high pressure lubrication between the pistons and the eccentric, which are in sliding contact with each other, at a reduced loading according to the ratio of the total piston area and total fluid column area.

Provision is made for hydraulic balancing of moving components, so that they operate under control of conditions of pressure differential permitting of high speed working of the pump.

An embodiment of the invention is illustrated, by way of example, in the accompanying drawings, wherein:—

Figure 1 is a longitudinal sectional elevation of the pump, on line A—A of Figure 2;

Figure 2 is a transverse sectional view in line B—B of Figure 1; and

Figure 3 is a detail view, to an enlarged scale of one of the pistons and its cylinder.

In the construction illustrated, a fixed or stationary pump casing is employed, said casing comprising a body 1 and a cover 2 with an interposed cylinder block 3, all suitably drilled for the reception of holding bolts 4, which may also serve for securing the pump as a whole in position on a suitable supporting structure. The body 1 and the cover 2 have central, axially aligned bores 1A, 2A enclosing needle bearings 5 for supporting the journals of a shaft 6 driven in any suitable manner.

The cylinder block 3 has a bore 3A which is larger than the body and cover bores and within said block bore 3A is accommodated an eccentric 7 forming part of or attached to said shaft 6 for rotation therewith. The transverse sectional shape of the shaft eccentric 7 is circular. The cylinder block 3 is also formed with a plurality of transverse cylinder bores 3B which break into the bore 3A and within each of said cylinder bores is a sleeve 8 which is mounted trunnion-fashion within its cylinder bore so as to be free to swivel therein, part of the periphery of the sleeve 8 protruding through the opening formed where the cylinder bore 3B breaks into cylinder block bore 3A.

Each cylindrical sleeve 8 has a through channel 8A extending from end to end, the open channel being closed at one end by the flat inner face 2B of cover 2 and at the other end by the flat inner face 9A of a pressure ring 9, accommodated in an annular recess 1B provided in the inner face of body 1. Pressure ring 9 serves to close another smaller recess 1C leading from recess 1B and constituting a delivery duct 10 whence fluid under pressure is delivered.

Between opposing parallel walls in the mouth of the through channel 8A of each sleeve 8 is slidably mounted a piston or plunger 11 of flat vane form, having a length substantially equal to the length of the sleeve 8, the outer end face 11A of said piston being of concaved circular arc form, with a radius of curvature equal to that of eccentric 7; the sleeve 8 thus forms with its associated vane-like piston 11 a piston and cylinder arrangement as used in reciprocatory pumps. By reason of the swivel action of sleeve 8 within the cylinder bores 3B the vane-like piston 11 is free to adjust itself to the circular-arc surface presented by the eccentric 7, so as to maintain sliding contact between said eccentric 7 and the piston face 11A. Each vane-like piston 11 is biased toward contact with the eccentric 7 by means of a coiled compression spring 12 interposed between the floor of the sleeve channel 8A and the bottom of a blind socket 11B provided in the inner face of piston 11. The sliding action of the pistons 11 in relation to said eccentric 7 thus causes them to function also as the vanes of a pump of sliding abutment type. Symmetrical to said spring socket 11B are through holes 11C which provide for flow of fluid between the concaved piston face 11A and the chamber formed within sleeve 8 between the inner face of said piston 11, the floor of the sleeve channel 8A and the faces 2B and 9A of cover 2 and pressure ring 9 respectively.

For a purpose hereinafter more particularly described the peripheral surface of sleeve 8 is relieved by a symmetrical base recess 8B and two asymetrically disposed side recesses 8C of tapering form in cross section, as shown in Figure 3. A base port 8D and side ports

8E (Figure 3) establish free communication for fluid between the interior of sleeve channel 8A and the recesses 8B and 8C respectively.

At a suitable position the pressure ring 9 has a passage 9B adapted at appropriate times to communicate in succession with the interiors of the sleeve channels 8A, said passage 9B being closed until opened by fluid pressure by means of a ball 13 biased by a coiled compression spring 13A thus constituting a check valve, the action of which is described later.

The peripheral surface of eccentric 7 is relieved by a groove 7A which is long enough to register with the spaced holes 11C in each vane-like piston 11. Into opposite ends of this eccentric groove 7A open two radial passages 7B in the eccentric 7 leading the bore 7C thereof, which leads into a bore 6A in shaft 6.

Some portion of the peripheral groove 7C of eccentric 7 is thus open at all times to the chamber 14 formed within the bore 3A of block 3, said chamber containing the eccentric 7, the protruding portion of swivel sleeves 8 and portions of the vane-like pistons 11. Chamber 14 communicates via passages 2C with an intake recess 2D which is connected by a feed coupling (not shown) secured by screws engaging tapped holes 2E; the shaft bore 6A also opens into recess 2D.

Oil or hydraulic fluid, hereinafter referred to as the liquid, is admitted through the central bore 6A in shaft 6 and the additional passages 2C in the intake recess 2D to the chamber 14 containing eccentric 7.

As the pistons 11 are urged by their springs 12 on the successive downward strokes to maintain contact with the periphery of eccentric 7 liquid passes through the holes 11C in the pistons via the relieving groove 7A of the eccentric 7 and/or the holes 7B from the bore 7C and shaft bore 6A. On the commencement of the upward stroke, the holes 11C in each successive piston are cut-off from the relieved portion of the eccentric 7 thus allowing the liquid to be discharged through the check valve 13 into the delivery duct 10.

When a piston 11 is at the top of its stroke the check valve 13 closes under its spring 13A and the holes 11C in the piston 11 register again with the relieving groove 7A of the eccentric 7, whereupon the cycle recommences.

In order to run the pump at high pressures, it is essential that the finite clearances between the pistons 11 and sleeves 8 should be controlled at a minimum. It is also necessary that the contact surfaces between the sleeves 8 and cylinder block 3 and the pistons 11 and eccentric 7 should be relieved of excess loading, which can be accomplished by utilizing hydraulic pressure in a manner now to be described.

It will be realised that the holes 11C in each piston 11 on the discharge stroke carry liquid at a pressure equal to the working pressure of the pump, and this liquid can be considered as columns of liquid which are discharged through the check valve 13 by means of the rotation of eccentric 7. These columns of liquid also serve to provide a means of high pressure lubrication between the pistons 11 and eccentric 7, which are slidably in contact with each other, at a reduced loading according to the ratio of the total area of pistons and associated liquid columns.

It will be seen from the drawings that the pressure chamber 15 provided inside each sleeve 8 is so designed that the pressure build-up in said chamber is also applied to three pre-determined areas on the outside of the sleeve through ports 8D and 8E. The areas "B" on each side of a sleeve 8 are equal to areas on the side walls of the pressure chamber 15, so as to equalise inside and outside pressures at right angles to the axis of the piston 11. "D" is the area of the floor recess 8B.

The total areas "A" and "D" are arranged so that there is always a tendency for the sleeve 8 to move radially inwards within the infinite clearance between sleeve 11 and cylinder block 3.

It will be seen that by closely controlling the differential of areas "A" and "D" to the piston area it is possible to control the force urging the sleeve 8 to move radially inwards, which at high pressures will tend to keep the clearance between sleeve 8 and piston 11 to a minimum, thus ensuring a seal between their contacting surfaces and enabling high pressure working in the pump. This control of differential will also enable clearance at low pressures to be satisfactorily arranged.

It is to be noted that the check valve 13 is housed in a pressure plate 9 which is always urged into contact with the side face of cylinder block 3 by the pressure build-up in the discharge or delivery passage 10, thus ensuring finite clearance between the sides of the pistons 11 and the cover 2.

One advantage of this construction is that in the event of wear on the sides of the pistons after long service, the initial finite clearance can be restored by lapping the surfaces of the cylinder block 3 and pressure plate 9, thus restoring the pump to its initial working efficiency.

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Chartered Patent Agents,
Agents for the Applicants.

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Fig. 4.

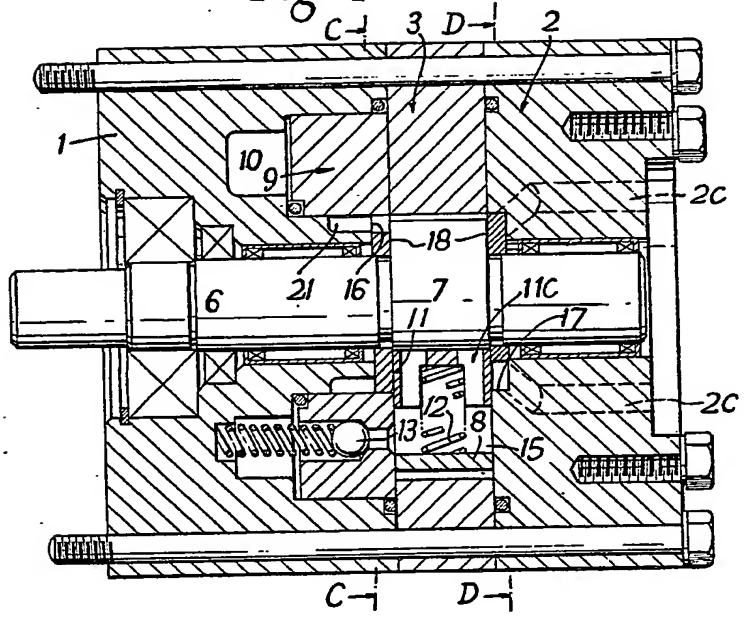


Fig. 5.

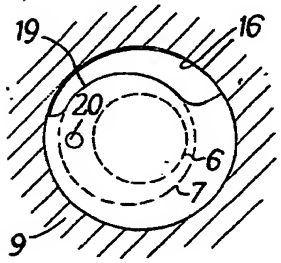
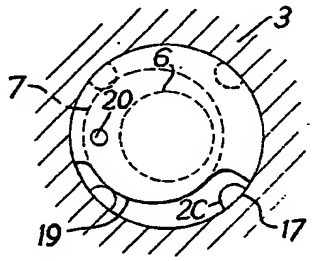
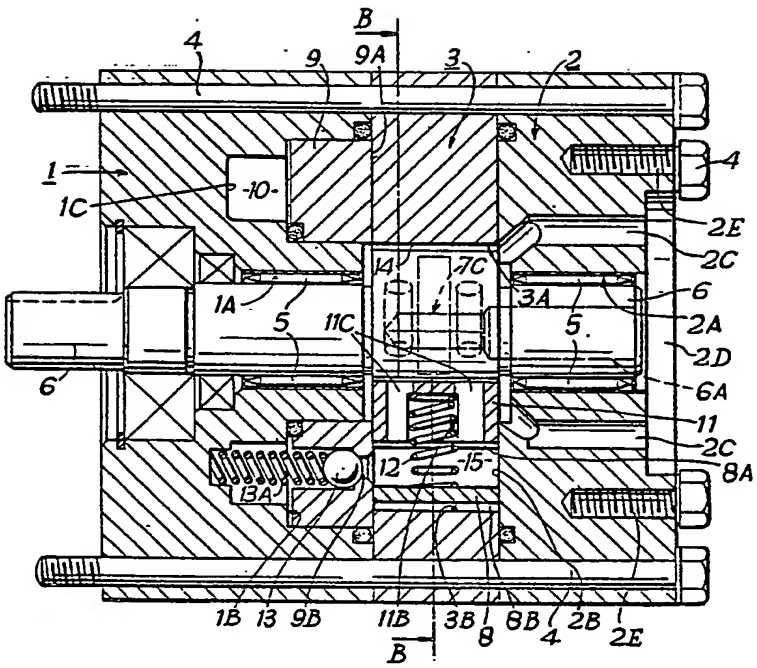


Fig. 6.

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2D
6
6A
11
2C
12
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8A
13A
1B
13
9B
11B
3B
8
8B
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2B
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B

Fig. 1.

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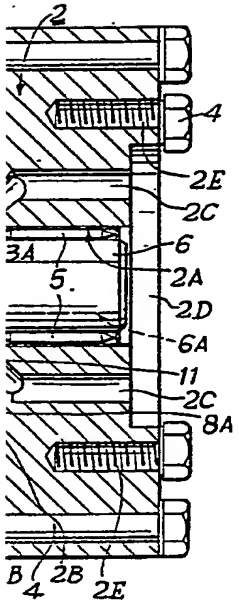
Sheets 1 & 2



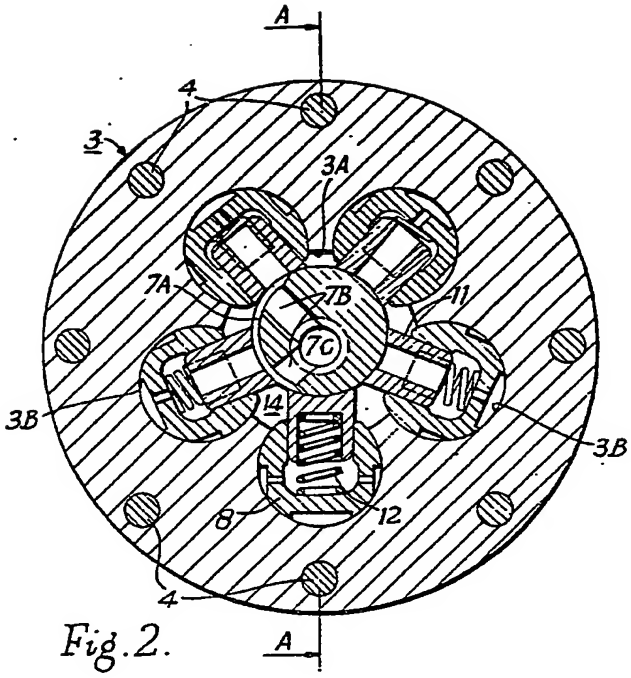


Fig.2.

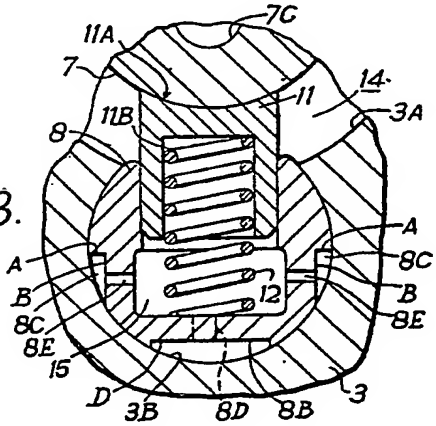


Fig.3.

884556 PROVISIONAL SPECIFICATION

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Sheets 1 & 2

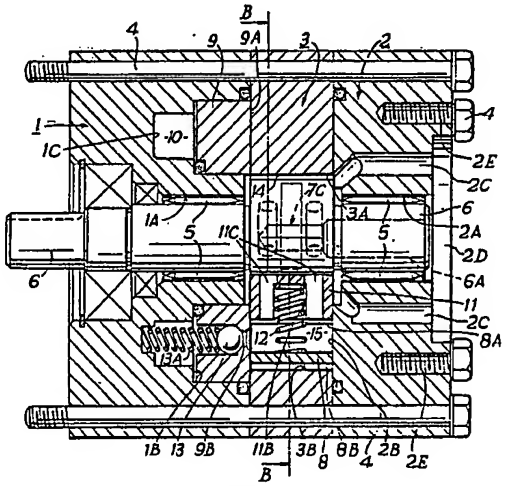

Fig. 1.

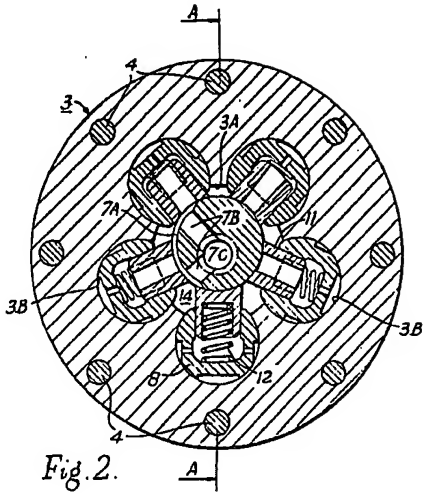

Fig. 2.

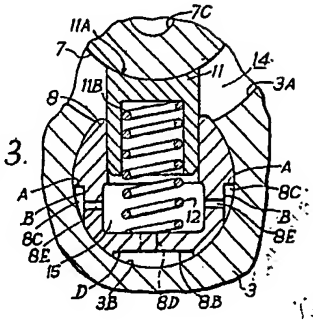

Fig. 3.